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CHANCES OF SURVIVING THE FIRST YEAR OF SERVICE: A NEW TECHNIQUE FOR USE IN MAKING RECRUITING POLICY AND SCREENING APPLICANTS FOR THE NAVY

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Recruits who joined the Navy during the first year of the all volunteer force were tracked through their first year of service. Background and selection test data were related to premature discharges from this cohort, and a table showing estimated chances of surviving the first year of service was produced. The table can be used for planning recruiting policy and screening applicants for enlistment.

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1. The Enlisted Tracking Study was commissioned to develop a model for estimating premature losses that could be used to plan recruiting policy and screen applicants for enlistment, and a model of recruiting district productivity that could be used to allocate quotas and canvassers and evaluate recruiting results. Enclosure (1) is the report of the work on estimating premature losses. Data was obtained on the background, selection test scores, and discharges of non-prior-service USN male recruits who entered the Navy in CY 1973, the first year of the all volunteer force. After this cohort was tracked through the first year of service, loss rates were calculated and related to the background and test data.

2. Seventeen percent of the recruits were discharged during the first year of service, and over half of the losses were attributed to character and behavior disorders and inaptitude/apathy. Education, mental group, age, race, and dependents together explained most of the differences between those who survived and those who were prematurely discharged. These characteristics should be used in combination, rather than separately, to maximize the validity of loss or survival estimates.

3. A table of estimated chances of surviving the first year of service was produced from the relationships among the above characteristics. It was recommended as having merit for use in planning recruiting policies and as a replacement for the odds for effectiveness in screening applicants for enlistments.

4. These recommendations have been reviewed and planning is underway to incorporate some of the findings of the study in recruiting plans and policies.

5. Enclosure (1) is forwarded.

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SUMMARY

Navy concern about premature losses of first-term enlistees led to this study. The study sought to develop a model of losses during the first year of service that could be used to evaluate recruiting policy changes and improve the screening of applicants for enlistment.

Data on nearly 67,000 non-prior service USN male recruits who entered the Navy in CY 1973 was available from the Navy Recruiting Command and the Bureau of Naval Personnel. It included background and selection test information, service history, and reasons for discharge. Mental ability groups were calculated from scores on the Basic Test Battery (Form 7) to conform with current testing policy. Formerly, a short version of the battery was administered to applicants; today, the full-length battery is given in the field.

Nine percent of the cohort was prematurely discharged during recruit training and 17 percent was discharged during the first year of service. Although reasons for losses are not precisely applied, Character and Behavior Disorders and Inaptitude/Apathy were cited in over half of the discharges. Nearly half of these discharges occurred during recruit training. Erroneous and fraudulent enlistments were cited in over a fourth of the discharges, and 90 percent of these discharges occurred in recruit training.

The highest first year loss rates were experienced by non-high school graduates, mental group IVs, minority recruits, men age 17, and those with primary dependents. However, basing recruiting policy on these individual measures would be unwise, because the relationships among them must be taken into account. To do this, the cohort was sorted into groups defined by different levels of the individual measures. For example, one group contained all men in mental group II who were high school graduates, 17 years old, minority, and had no dependents. The first year loss rate was calculated for each group. Then, using the groups as units of observation, weighted regressions of the individual measures on the loss rates were computed. This analysis showed that education, mental group, primary dependents, race, and age were significant correlates of first-year loss rates, explaining most of their variation across groups.

The chances of non-school eligible high school graduates surviving the first year of service were found to be greater than those of school eligible non-high school graduates. From the standpoint of first year survival, when requirements for men eligible for Class A School have been met, the Navy is better off recruiting high school graduates who are not eligible for school than non-high school graduates who are.

In relation to this finding, recruiting limitations on non-school eligible high school graduates have a special effect on minority applicants who on the average score lower on the Basic Test Battery that is used to determine school eligibility. This makes it more difficult for them to qualify for Class A School in the first place. Further, the first year survival rate of minority recruits who were not school eligible was higher than that of majority recruits.

The fact that the short Basic Test Battery used in the field overestimated the mental group of non-school eligibles, coupled with larger proportions of non-high school graduate accessions, probably was responsible for much of the increase in premature separations beginning in FY 1973. Another

factor in this situation is a growing tendency on the part of the Navy to discharge problem sailors as soon as possible, thereby minimizing disciplinary, administrative, and supervisory burdens.

In planning recruiting policy, predicted survival rates derived from the model developed in this study can be applied to different recruit inputs defined by percentages of high school/non-high school graduation and school eligibility/non-eligibility. This would produce expected first year survival figures that can be evaluated by planners in setting goals or modifying them as a result of recruiting experience and the needs of the service.

Concomitantly, the table of chances of surviving the first year of service could be used by recruiters as a replacement for the Odds for Effectiveness in screening loss-prone applicants: not only is it current, comprehensive, and easily applied, but it has the same basis as the estimates mentioned above for use in calculating the probable effects of various recruiting policies.

CONCERN ABOUT FIRST-TERM LOSSES

LOSS RATES

In planning recruiting policy, the Navy uses a four-way combination of educational level and mental ability in conjunction with the number of recruits needed:

	High school graduate	Non-high school graduate
School eligible	A	B
Non-school eligible	C	D

School eligibles are those with above average mental ability on the Basic Test Battery used for selection into the Navy and into Class A Schools.

Recruiting goals are set by specifying the desired ratio of recruits in the categories to one another (e.g., 4 A+B for each C or D) or the desired percentages of high school graduates and school eligibles. Within these goals, recruiters in the field use an Odds for Effectiveness (OFE) table that tells the chances in 100 that an applicant will complete a four-year enlistment. The OFE table is based on education, mental ability, and expulsions or suspensions from school.

With the onset of the all-volunteer force in 1973, the Navy became concerned about the losses of first-term enlistees before the expiration of their obligated service. Nearly 30 percent of enlistees in 1970 had been prematurely separated by the end of 1974, excluding men who were not recommended for reenlistment (reference 1), and projections for subsequent years were even higher (reference 2). However, ten years earlier, the loss rate at the end of 4 years of service was about the same, although it included men who completed their terms but were not recommended for reenlistment (reference 3).

COSTS

The Navy was concerned not only about the effects of the losses on training plans and fleet readiness, but also about the dollar costs of premature separations. The average cost of getting one recruit through recruit training and Class A School or apprenticeship training exceeded $7,000 in FY 1975:[1]

	Recruit training	A school or apprentice training	Total
Procurement	$ 440	0	440
Travel	130	154	284
Pay, uniform	1,142	1,608	2,750
School costs	638	3,000 - 6,000	3,638 - 6,638
	$2,350	4,762 - 7,762	7,112 - 10,112

[1]Source: CHNAVPERS (Pers-2122B1), 1 March 1976.

With an annual input of 100,000 men and a first year loss of 15 percent, the attrition cost could easily exceed 100 million dollars, and this would not take into account the costs of empty training seats and fleet billets.

EARLIER WORK ON LOSS FORECASTING

During the early 1960s, the military services studied the problem of premature separations during the first enlistment term. Education, mental ability, and age were found to be the best background variables for predicting first-term survival in all of the services, generally yielding multiple correlations around .35 with various survival criteria (reference 4).[1] A recent Marine Corps study of 65,000 recruits in initial four-year terms who were separated during CY 1971-1973 produced the same kind of results (reference 5).

OTHER ON-GOING LOSS STUDIES

Two other Navy efforts are using specially administered personality and adjustment tests, in addition to routinely available background variables, to track samples of enlisted personnel during their first enlistments:

- The Navy Personnel R&D Center (NPRDC) administered special tests to a cohort of female recruits in January 1975. These women will be followed up a year later to determine the relationships of the special test and other background data with survival of the first year of service.

- The Navy Health Research Center (NHRC) (formerly the Neuro-Psychiatric Research Unit that developed the Odds for Effectiveness table) administered a special test to 4,000 male recruits at NTC San Diego in FY 1974. The Center is following this cohort through recruit training, Class A School, 2 years of service, and to the end of the first enlistment.

Both of these efforts include important variables that cannot be routinely obtained from Navy recruiting or personnel files. They represent probably the best long-range prospects for substantial improvement in selecting recruits most likely to successfully complete their enlistments.

Meanwhile, readily available background variables can be related to recruit training and first year losses for large cohorts of male non-prior service recruits with active duty base dates in CY 1973.[2] And today, the Chief of Naval Personnel and Commander, Navy Recruiting Command need an effective means of screening out prospective recruits that can also be used in evaluating recruiting policy alternatives.

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[1]The OFE resulted from the Navy's research on a sample of recruits at this time (reference 6). It was modified in 1973 to eliminate arrests for non-traffic offenses, because recruiters had difficulty getting this information from the courts.

[2]The use of large numbers of men will make it possible to avoid statistical problems posed by loss/survive dependent variables of the type in the OFE (reference 7).

STUDY GOAL

Consequently, the goal of this study was to develop a model of premature losses that could be used in planning recruiting policy and screening loss-prone applicants, using available data on a cohort of all-volunteer recruits.

A second goal sought to explain differences in the productivity (enlistment rates) of Navy Recruiting Districts that could be employed in setting quotas, allocating canvassers, and evaluating district outcomes. It was pursued separately (reference 8), but complements the study reported here by identifying the market and means for obtaining recruits.

MEANS FOR ACHIEVING THE STUDY GOAL

DATA AND COHORT

Background data on recruits in CY 1973 came from Armed Forces Entrance and Examining Stations (AFEES) via the Navy Recruiting Command. It included date of birth, education, AFQT score and mental group, term and program of enlistment, race, dependents, and recruiting district. Reasons for discharge during recruiting training came from the Navy Recruit Training Commands (RTC) also via the recruiting command.

The sample contained 66,680 males, almost the entire cohort of USN non-prior service recruits with an active duty base data in CY 1973.[1] By this time, the effects of the draft on recruiting had diminished; we estimated that only 1,539 of the men were draft-motivated, using a technique reported in reference (9). Enlisted Master Records (EMR) and Loss Tapes from the Bureau of Naval Personnel enabled us to track the cohort through the first year of service and provided additional data on Basic Test Battery (BTB) scores, loss codes, rate/rating, and assignment. We assumed that this kind of data would be sufficient to permit reasonable statistical differentiation of survivors from non-survivors at various stages of their first enlistment terms. Other studies on small cohorts have included psychiatric, civilian school, home background, and police record data that are not available for our large cohort or for the general screening of applicants.

Table 1 shows the characteristics of the cohort. Typical recruits enlisted for 4 years, had no dependents, were 18 or 19 years old, had 12 years of education, were from the racial majority, and qualified for special training programs. By the end of recruit training, 9 percent of them had been prematurely discharged; by the end of the first year of service, the figure was 17 percent.[2]

LOSSES DURING RECRUIT TRAINING

About 27 percent of the cohort did not have Odds for Effectiveness (OFE) scores. Their loss rate from recruit training was average, the same as that of the 68 percent who had OFE scores of 69 or above. However, the remaining 5 percent of the cohort whose OFE scores were less than 69 and were waived had twice the average loss rate.

From January through August 1973, recruit training was 7.6 weeks long. Beginning in September 1973, it was increased to 9 weeks. Over 60 percent of the losses occurred during the third through sixth weeks of training; 95 percent occurred by the end of 14 weeks due to setbacks for a variety of reasons.

The reported reasons for attrition from recruit training and the distribution by Recruit Training Command are shown in table 2. The reasons were classified according to the scheme used in

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[1] Actual CY 1973 figures were 67,968 male non-prior service recruits, the difference being due to reporting and computer tape errors. Data was also collected on 6,326 of 6,485 female USN non-prior service recruits and will be analyzed at a later date.

[2] These percentages are underestimates of the actual rates because of accession and attrition records that did not match due to incorrect social security numbers. CNRC has estimated an unmatched rate of 15 to 20 percent at the recruit training stage. Since mismatches are probably a random sample from the cohort, the results of the analysis should not be biased by their absence.

TABLE 1

DESCRIPTIVE DATA ON CY 1973 USN NON-PRIOR SERVICE MALE RECRUITS (N = 66,680)

Term	%
3 years	26.0
4 years	62.2
6 years	11.8

Age*	%	
17	14.9	
16	34.0	59.6
19	25.6	
20	13.1	25.5
21	6.1	
22	3.0	
23	1.7	
24+	1.6	

Years of education	%	
8	0.4	28.9
9	2.7	
10	12.2	
11	13.6	
12	63.3	
13	4.0	7.8
14	2.5	
15	0.6	
16	0.7	

Primary dependents	%	
None	93.8	
Wife	3.5	6.2
Wife & child	2.4	
Wife & children	0.3	

Active duty base date month	%	
Jan	7.3	44.8
Feb	6.7	
Mar	6.6	
Apr	5.8	
May	5.9	
Jun	12.5	
Jul	11.6	55.3
Aug	11.9	
Sep	11.5	
Oct	8.3	
Nov	6.8	
Dec	5.2	

Religion	%
Protestant	61.2
Roman Catholic	28.2
None	9.4
Other	1.1

Race	%
Majority	89.3
Black	9.7
Other minorities	1.0

Navy recruiting area	%
1 Albany	14.7
2 Richmond	9.0
3 Macon	10.7
4 Columbia	13.0
5 Chicago	13.5
6 Omaha	10.1
7 Dallas	11.7
8 San Francisco	17.1
– Other	0.3

Special Program	%
None	35.8
Occupational specialty	32.8
School guarantee	18.4
Advanced electronics field	6.4
Nuclear field	5.4
Direct procurement petty officer	1.0
Vocational fields	0.2

Type acquisition	%
Non-prior service	51.1
CACHE	48.9

Losses	%
Recruit training	9.0
1st year of service	17.2

Mental group (based on BTB-7)	%	AFQT percentile
I	4.5	93 & above
II	36.1	65-92
IIIU	23.4	49-64
IIIL	18.5	31-48
IV	17.5	30 & below

*As of active duty base date.

TABLE 2

PERCENTAGES OF CY 1973 MALE RECRUIT LOSSES BY RTC

Reason	Great Lakes	San Diego	Orlando	Total
Non-medical:				
Character & behavior disorders	12	36	62	32
Inaptitude/apathy	21	6	9	14
Fraudulent enlistment	25	19	8	18
Medical:				
Enlisted in error	41	33	3	29
Physical disability	–	5 (38)	18 (21)	6 (35)
Percent of recruit input	36	35	29	100
Percent of recruit losses	44	29	27	100
Loss rate	10.9%	7.3%	8.3%	9.0%

reference (2) by the Bureau of Naval Personnel. Character and Behavior Disorders (32% of the total) refer to personality and adjustment problems. Inaptitude/Apathy (14%) refers to learning and motivational problems. Fraudulent Enlistment (18%) is enlistment under false pretenses, here due mostly to drug use prior to enlistment that was not discovered until recruit training. Enlisted in Error (29%) includes honest mistakes in the enlistment process made by the recruit or the Navy; here it was used mostly to discharge men for pre-existing physical conditions passed or not discovered by AFEES medical examiners, but discovered or disallowed by RTC medical staffs. Physical Disability (6%) refers to medical problems incurred during training which were of sufficient gravity to warrant discharge from the Navy.

Taking these reasons at face value, we see obvious differences among the Recruit Training Commands. San Diego had 35 percent of the recruit input, but only 29 percent of the losses. In contrast, Great Lakes had 36 percent of the input, but 44 percent of the losses.

Losses due to medical reasons were highest at Great Lakes (41 percent) and lowest at Orlando (21 percent). However, losses due to Character and Behavior Disorders were highest by far at Orlando (62 percent) and lowest at Great Lakes (12 percent). Conversely, losses due to Fraudulent Enlistment–drug use–were highest at Great Lakes (25 percent) and lowest at Orlando (8 percent).

Looking at these results might lead one to surmise that the medical staff at Great Lakes was oriented toward physical problems and strict in its standards, whereas the staff at Orlando was oriented toward psychological problems. Then there is the possibility, supported by anecdotal evidence, that when a decision has been reached to separate a recruit, the easiest legal path is used to expedite his discharge. For example, if one RTC has an efficient Aptitude Board, many of its separations are likely to be due to Inaptitude/Apathy. If another RTC has an efficient Medical Board, many of its separations are likely to take the medical route.

For these reasons, we cannot be sure that some of the reasons for discharge mean the same thing or are used consistently at the different RTCs. Consequently, we lumped them all together, a practice that has been used before in the Navy and the other services when analyzing losses.

When we look at total RTC losses by race, differences among the RTCs also appear. About 11 percent of the cohort was from minority groups, and about 90 percent of them were Black. Table 3 shows that Great Lakes had proportionate inputs and losses of majority and minority recruits. San Diego had a disproportionately smaller input of minorities with a somewhat higher loss rate than the majority. More remarkable, Orlando had a disproportionately higher input of minorities with a sizeably higher loss rate than the majority. Overall, the minority loss rate was higher than that of the Caucasians, 11.2 compared to 8.8 percent.

TABLE 3

CY 1973 RTC INPUT AND LOSSES BY RACE

	Majority		Minority	
	% input	Loss rate	% input	Loss rate
Great Lakes	36	11.1%	37	11.8%
San Diego	36	7.3%	28	8.8%
Orlando	28	7.9%	35	12.5%
Total	100	8.8%	100	11.2%

LOSSES DURING THE FIRST YEAR

The distributions of losses during the first year of service by RTC are shown in table 4.

TABLE 4

CY 1973 RECRUIT LOSSES DURING THE FIRST YEAR BY RTC

	% input	% of RTC losses	% of 1st year losses
Great Lakes	36	44	43
San Diego	35	29	30
Orlando	29	27	27

	Loss rate	
	In RTC	1st year
Great Lakes	11.2%	20.6%
San Diego	7.4%	14.8%
Orlando	8.4%	16.0%
Total loss rate	9.0%	17.2%

Great Lakes maintained its disproportionate share of losses while the other two RTCs' losses were proportionate to their inputs. However, some of the differences among the RTCs are due to the mix of their recruits. If the first year loss rates were adjusted by mental group and educational level, the rate for Great Lakes would drop two percentage points, San Diego would increase by the same amount, and Orlando would be unchanged.

The first year loss from the cohort amounted to 17.2 percent. In other words, 1 out of every 6 recruits who entered the Navy in calendar year 1973 was prematurely separated during his first year of service.

Table 5 shows that 52 percent of the losses occurred by the end of the recruit training. Most of the losses for Erroneous and Fraudulent Enlistments occurred by then, compared to about half of the Character & Behavior Disorders and Inaptitude/Apathy cases and about a third of the Physical Disabilities. Separations due to Court Involvement with civil authorities and Alcohol/Drug Related reasons did not appear until after recruit training.

TABLE 5

FIRST YEAR LOSSES AND PERCENTAGE INCURRED DURING RECRUIT TRAINING BY REASON FOR PREMATURE DISCHARGE

Reason	% of 1st year losses		% in recruit training
Character & beahvior disorders	37.6	52.3	45
Inaptitude/apathy	14.7		49
Enlisted in error	16.3	27.1	91
Fraudulent enlistment	10.8		89
Physical disability	9.5		36
Court involvement	6.6		0
Alcohol/drug related	1.8		0
Other	1.8		17
Hardship	0.9		3
Total	100.0		52
Number	11,493		6,040

From the standpoint of length of service, 32 percent of the losses occurred before the end of the second month, and 50 percent before the end of the third month (12 weeks). Thereafter, about 4 to 5 percent occurred each month up to the one year point. Approximately 75 percent of the losses occurred before the end of the eighth month.

Finally, we looked at the on-board activity of the first-year losses in the Enlisted Master Record. The results were not helpful: "General Duty" was the activity listed for 42 percent of the losses, but it was applied during recruit training and the rest of the first year; "Student" applied to men in recruit training and specialized training; and code 000000 (which may mean "Anywhere

TABLE 6

FIRST YEAR LOSSES AND PERCENTAGE INCURRED DURING 1st 12 WEEKS BY ON-BOARD ACTIVITY

Activity	% of 1st year losses	% incurred in 1st 12 weeks
General duty	41.7	44
Student & NTCs	35.3	65
Ships & squadrons	9.3	0
Hospitals	2.5	5
Misc. shore	0.6	0
Code 000000	10.4	66
Unknown	0.3	0
Total	100.0	51

USA") was also used for losses during recruit training and thereafter. Consequently, accurate analysis of losses by activity cannot be made.

LOSS MODEL

The explanatory variables selected for use in our loss model were picked because they (1) are available early on all prospective recruits (biographical and mental test variables); (2) are outside the control of the Navy (as opposed to the case of special programs, medical waivers, and assignments to RTCs); and (3) apply to a sufficiently large number of potential recruits so that sampling error is not excessive. Applying this rationale left five variables for analysis: education, mental group, age, race, and primary dependents.

Since there were 66,680 males in the cohort, and since the use of a dummy dependent variable like loss/survive would lead to statistical problems in the regression analysis (references 7 and 10), the recruits were grouped by combinations of the levels of the explanatory variables. The levels were defined in dummy variable form for both qualitative measures such as race, and quantitative measures such as age and education, where broad groupings were relevant. The dummy variables were based on the distributions shown earlier in table 1.

Loss rates were then calculated for each group of recruits defined by the various levels of explanatory variables (such as mental group II, high school graduate, age 18 or 19, no dependents, minority).

This resulted in 180 possible groups of recruits, of which 148 contained data. These 148 groups became the units of observation for the weighted regression analyses of dummy variables on loss rate. The specification of the loss model is contained in appendix A.

Cross-validation of the model may not be necessary because of the large number of observations (or, more correctly, relatively large groups of observations) and the small number of explanatory variables. It can be carried out, however, on a later cohort once the data matures.

LOSS PATTERNS

DISTRIBUTIONS OF INDIVIDUAL VARIABLES

In looking at the individual distributions of the background variables, we became aware of significant differences in mental group distributions used for recruiting and classification.

Different Bases for Mental Groups

In calendar 1973, the Short Basic Test Battery (SBTB) was used by recruiters for selecting recruits into the Navy. The GCT, ARI, and MECH test scores from the SBTB were added and converted to an AFQT percentile score that determined a recruit's mental group. When a recruit got to a Recruit Training Command, he took a longer version of the Basic Test Battery (BTB-7) for classification to Class A School or to the fleet. The BTB had been validated against final Class A School grades, whereas the SBTB had not. Further, even though the short battery stemmed from the longer one, their scores were not—and could not be—perfectly correlated. This meant that some men who qualified for Class A School on the SBTB did not on the BTB-7, and vice versa. In addition, quotas were set for mental groups on the basis of BTB-7, whereas recruiters had to determine mental group using the SBTB.

Today, the BTB-8 is administered by Personnelmen classifiers at various Navy Recruiting Stations, so the problem of different selection and classification tests has disappeared. But in 1973 and 1974 the problem was very much in evidence.

To make our analysis compatible with 1975 testing policy, we recalculated mental group using the BTB-7 scores from the Enlisted Master Record. BTB-7 scores were found for 88 percent of the first-year survivors on the December 1973 EMR, but for only 54 percent of the first-year losses on Loss Tapes from January 1974 through April 1975. To predict missing BTB scores, we summed the GCT, ARI, and MECH test scores (G+A+M) and correlated the total with the AFQT percentile derived from the SBTB for the 84 percent of our cohort who had both batteries. The simple correlation coefficient was .81. Then, we calculated a regression equation to predict BTB-7 G+A+M from AFQT percentile score:

$$\text{BTB-7 G+A+M Score} = .89\ \text{AFQT Percentile} + 102.92$$

Finally, the predicted scores were converted to mental groups using the Navy table below:

Navy standard score from BTB-7 (G+A+M)	Mental group
190+	I
161-189	II
148-160	IIIU
136-147	IIIL
107-135	IV

The net result of this procedure is shown in table 7. The biggest differences occurred for mental groups IIIL and IV. Whereas 29 percent of the cohort were IIIL on the SBTB, only 19 percent were on the BTB-7. More important, whereas only 3 percent were mental group IV on the SBTB, 18 percent were in category IV on the BTB-7.[1] The differences affected the percentage of school eligibles, those in mental groups I through IIIU: 68 percent were school eligible on SBTB, compared to 63 percent on BTB-7.

TABLE 7

EFFECT OF SELECTION BATTERY ON MENTAL GROUP DISTRIBUTION

Mental group	Mental group basis		
Mental group	AFQT (SBTB) (%)	BTB-7 (%)	Diff. (%)
I	3	4	+1
II	36	36	0
IIIU	29	23	-6
IIIL	29	19	-10
IV	3	18	+15
I-IIIU (school eligible)	68	63	-5
IIIL-IV (non-school eligible)	32	37	+5

Thus, the use of the SBTB to determine mental group led, in effect, to a lowering of recruiting standards in CY 1973. This effect persisted through CY 1974, when recruiting quotas were higher and the SBTB mental group distribution was lower than in CY 1973. Also, the percentage of high school graduate accessions dropped from 76 percent in 1972 to 69 percent in 1973 and 1974. Since education and mental group are the two strongest predictors of premature discharges, it was to be expected that loss rates would increase for the 1973 and 1974 cohorts. Furthermore, there has been a growing tendency for the Navy to discharge problem sailors as soon as possible to minimize disciplinary, administrative, and supervisory burdens. This, too, added to the premature loss rate.

Accession and Loss Rates by Background Variables

The percentage distributions of loss rates during recruit training and at the end of the first year are given in table 8. These are one-dimensional in the sense that the combined effects of the five variables have not been taken into account in the loss model. Nonetheless, they reveal some interesting and useful facts.

Individually, the highest loss rates are for non-high school graduates, age 17, mental group IV, minorities, and those with primary dependents. Obviously, we would not want to exclude all applicants who fall into any one of these categories, because we would lose a significant portion of total accessions. The loss model will put these background variables together to determine their joint effects.

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[1]Since the relationship between SBTB and BTB-7 mental group is not linear, the estimated BTB-7 distribution for IIIL and IV may be biased upward.

TABLE 8

ACCESSION AND LOSS RATES BY BACKGROUND VARIABLES

		% CY 1973 accessions	Loss rate	
			RTC	End 1st year
Education	> 12	8	4.4	9.3
	12	63	6.6	13.2
	< 12	29	15.5	28.3
Age	17	28	11.6	22.5
	18 & 19	55	7.7	14.8
	20+	17	8.8	16.4
MG	I	4	1.0	5.0
	II	36	5.0	11.3
	IIIU	23	7.8	16.1
	IIIL	19	12.8	23.1
	IV	18	16.9	28.1
Race	Majority	89	8.7	16.9
	Minority	11	11.1	20.3
Dependents	No	94	8.8	16.9
	Yes	6	11.9	21.8
Total		100	9.0	17.2

Accessions and loss rates by race are shown in table 9. The overall first-year loss rate is 20 percent for minorities and 17 percent for the majority. The fact that minorities do not score as well on the Basic Test Battery (reference 4) is apparent in the mental group distribution: 77 percent of them were in the lower two mental groups compared to 31 percent of the majority. Nevertheless, the loss rates by mental groups are not remarkably different for the two racial groups except for mental group IV, where the majority rate is sizeably larger.

Finally, we cross-tabulated Navy school eligibility and civilian education status by race. Table 10 reveals that only 23 percent of the minorities were school eligible compared to 69 percent of the majority. However, their loss rates were the same. The loss rate of the non-school eligible majority, however, was several percentage points higher than that of the minorities. About 70 percent of both groups were high school graduates, and their loss rates were similar. Also, for both groups the loss rates of school eligibles who were not high school graduates were greater than those of non-school eligibles who were high school graduates, substantially so for the minorities.

APPLICATION OF THE LOSS MODEL

The education, mental group, age, race, and primary dependent background variables now were combined with group loss rates in weighted linear and logit regression models to estimate first year losses. The plan was to eliminate variables or levels of variables that did not contribute significantly to the loss estimation, repool the groups, and recalculate the loss rates in preparation for the next regression analysis. As it turned out, all of the independent variables were significant at the 1 percent level in the first analysis.

TABLE 9

FIRST YEAR ACCESSION AND LOSS RATES BY RACE

		Majority		Minorities	
		% accession	Loss rate	% accession	Loss rate
Education	> 12	8	9	8	10
	12	64	13	60	16
	< 12	28	28	32	31
Age	17	28	22	23	23
	18 & 19	56	14	53	19
	20+	16	16	24	19
MG	I	5	5	*	*
	II	40	11	8	9
	IIIU	25	16	15	15
	IIIL	18	23	27	23
	IV	13	31	50	22
Total		100	17	100	20
Number		59,552	10,054	7,128	1,444

*Only 18 accessions of whom none were lost.

TABLE 10

ACCESSION AND 1st YEAR LOSS RATES BY SCHOOL ELIGIBILITY, EDUCATION, AND RACE

		Majority (59,552)			Minorities (7,128)		
		HSG	Non-HSG	Total	HSG	Non-HSG	Total
School eligible	% accessions	56.4	12.6	68.9	18.6	4.3	23.0
	Loss rate (%)	10.5	22.2	12.6	9.4	26.1	12.6
Non-school eligible	% accessions	15.2	15.9	31.1	49.4	27.6	77.0
	Loss rate (%)	19.9	32.4	26.3	17.2	32.1	22.6
Total	% accessions	71.6	28.4	100.0	68.0	32.0	100.0
	Loss rate (%)	12.5	27.9	16.9	15.1	31.3	20.3

The results of this analysis are contained in table 11, where the variables are listed in order of their importance in explaining the loss rates in the linear model. Because the results for the two models were very similar, the simpler linear model was chosen for use.[1]

Tables B-1 and B-2 in the appendix show the CY 1973 inputs of majority and minority recruits for each group, actual first year loss rates, and loss rates estimated from the linear model. The actual and predicted rates are very close, particularly for the larger groups.

[1]The correlation of linear and logit chances for all members of the cohort was .983.

TABLE 11

WEIGHTED REGRESSION RESULTS FOR LINEAR AND LOGIT FIRST YEAR LOSS MODELS: 148 GROUPS

Explanatory variable	Linear			Logit		
	Coefficient	t	rp*	Coefficient	t	rp*
Constant	.118	26.89	–	-1.976	-57.35	–
< 12 years education	.111	19.03	.852	.701	21.20	.875
MG IV	.100	13.44	.754	.597	14.23	.772
MG I	-.078	-10.85	-.680	-.989	-8.37	-.582
MG IIIL	.052	7.91	.560	.365	8.85	.603
Age 20 & above	.032	5.43	.421	.280	6.43	.482
MG II	-.026	-5.28	-.411	-.254	-6.22	-.469
Minority	-.034	-4.89	-.386	-.119	-2.64	-.220
> 12 years education	-.031	-4.49	-.358	-.314	-4.42	-.353
Primary dependents	.038	4.36	.349	.389	6.95	.510
Age 17	.015	2.89	.240	.093	2.76	.230
R^2	.924			.929		
Standard error	.023			.170		

*The correlation of the explanatory variable with the dependent variable when the other variables are held constant.

CHANCES OF SURVIVING THE FIRST YEAR OF SERVICE

The chances out of 100 of surviving the first year of service are shown for majority and minority recruits in table 12. They were calculated by subtracting the predicted loss rates from 100. The standard error in estimating the chances is 2 percentage points. Thus, actual survival (and loss) rates can be expected to fall in the interval of the predicted chances ±2 percentage points 2 out of 3 times, and ±4 percentage points 95 out of 100 times.

CHANCES OF SURVIVING AND ODDS FOR EFFECTIVENESS

The correlation between the chances and Odds for Effectiveness[1] scores for 48,793 men in the cohort who had OFE scores was .79. The means and standard deviations of the two measures are given in table 13. From these statistics, OFE can be predicted from chances with a ±6 percentage point standard error using the equation .90 Chances + 10.20. Conversely, Chances can be predicted from OFE with a ±5 percentage point standard error using the equation .69 OFE + 24.46. For example, an OFE of 69 is equivalent to a predicted chances value of 72.

IMPLICATIONS FOR RECRUITING

Predicted first year survival rates for the recruit quality categories depicted below are shown in table 14 for the two racial groups.

	High school graduate	Non-high school graduate
School eligible	A	B
Non-school eligible	C	D

A recruiting policy that excludes applicants in the D category would have eliminated 28 percent of minority recruits, compared to only 16 percent of the majority in the CY 1973 cohort. Recruiting policy that limits the C category to 1 for each 4 A+B (school eligible) applicants would also have severely restricted minority recruiting in CY 1973, since nearly half of the minority recruits were in the C category. Interestingly enough, the survival rate of the C category was about 3 percentage points higher than that of the B category for both majority and minority recruits. Further, the survival rate of minorities exceeds that of the majority by about 2 percentage points in each category.

These results underscore the value of looking at the background variables jointly; for example, the overall loss rate for minorities was higher than that of majority recruits, but only because of the disproportionately large percentage of minorities who were not school eligible (77 percent compared to 31 percent of the majority recruits).

With regard to school eligibility, it is more difficult for minority recruits to qualify for Navy schools, because they score on the average 7 to 8 points lower on the BTB tests used to qualify men for school (reference 4).

[1] Based on education, mental group, school suspensions/expulsions, and arrests for non-traffic offenses.

TABLE 12

CHANCES OF SURVIVING THE FIRST YEAR OF SERVICE*

Years of education:		Majority						Minority					
		>12	12	>12	12	<12		>12	12	>12	12	<12	
MG	Age	No dependents		Dependents		No dependents	Deps	No dependents		Dependents		No dependents	Deps
I	18-19	99	96	95	92	85	81	99	99	98	95	88	84
	17	97	94	93	90	83	79	99	98	97	94	87	83
	20+	96	92	92	89	81	78	99	96	96	92	85	83
II	18-19	94	91	90	87	80	76	97	94	93	90	83	79
	17	92	89	89	86	78	74	96	94	92	90	82	78
	20+	91	88	87	84	76	73	94	91	90	87	80	76
IIIU	18-19	91	88	87	84	77	73	95	92	91	88	80	77
	17	90	87	86	83	76	72	93	90	89	86	79	75
	20+	88	85	84	81	74	70	91	88	88	85	77	73
IIIL	18-19	86	83	82	79	72	68	89	86	86	83	75	71
	17	85	81	81	78	70	67	88	85	84	81	74	70
	20+	83	80	79	76	69	65	86	83	82	79	72	68
IV	18-19	81	78	77	74	67	63	85	82	81	78	70	67
	17	80	77	76	73	66	62	83	80	79	76	69	65
	20+	78	75	74	71	64	60	81	78	78	75	67	63

*Standard error of estimate equals ±2 percentage points.

TABLE 13

MEANS AND STANDARD DEVIATIONS OF CHANCES AND OFE SCORES FOR CY 1973 COHORT MEMBERS*

	Mean	Standard deviation
Chances	82.20	8.29
OFE	83.92	9.47

*Based on 48,793 men who had OFE scores.

TABLE 14

PREDICTED CHANCES OF SURVIVING THE 1st YEAR OF SERVICE BY CNRC QUALITY CATEGORIES

	Majority		Minority	
Quality category	% input	Predicted survival rate	% input	Predicted survival rate
A	56.4	89.6	18.6	91.6
B	12.6	76.8	4.3	79.7
C	15.2	80.2	49.4	82.3
D	15.8	68.2	27.6	70.7
A+B	69.0	87.3	22.9	89.4
A+B+C	84.2	86.0	72.4	84.6
Total	100.0	83.2	100.0	80.7

An example of how predicted survival rates can be used by manpower planners is shown in table 15. Suppose that the planners would like the quality distribution of non-prior service USN male recruits shown in the second column of the table (60 percent category A, and so on). Suppose also that they want to access 67,000 recruits during the next fiscal year. Multiplying this figure by the desired quality percentages will produce the input numbers in the third column of the table. These

TABLE 15

PREDICTED 1st YEAR SURVIVORS GIVEN DESIRED QUALITY MIX AND INPUT

Quality category	Desired % input	Input (based on 67,000 goal)	X	Predicted survival rate	=	Predicted survivors
A	60	40,200		89.6		36,019
B	20	13,400		76.8		10,291
C	10	6,700		80.2		5,373
D	10	6,700		68.2		4,569
Total	100	67,000		—		56,252

input numbers then are multiplied by the predicted survival rates to find the predicted numbers of survivors after one year of service, shown in the last column. The total of predicted survivors is 56,252 or 84 percent of the planned input of 67,000 men. This example used input data for FY 1975 majority recruits. A similar calculation could be made for minorities.

If planners can specify a desired number of survivors by quality category after one year of service, the number of accessions to achieve this goal can be calculated as illustrated in table 16. In this case, the desired number of survivors is multiplied by the predicted survival rate divided into 100 to find the number of accessions required. The example shows, among other things, that over 71,000 recruits are needed to produce 60,000 survivors for the desired mix by quality category at the end of one year of service.

The predicted survival rates for the four quality categories can be applied to (1) any input mix to predict the number of survivors, or (2) any mix of survivors to calculate the input needed to produce it. This can be done separately for minority and majority recruits. The standard error of 2 percentage points attached to the predicted survival rates always should be kept in mind when making these projections. Perhaps it would be wise for planners also to calculate pessimistic estimates of survivors by reducing the predicted survival rates by 2 percentage points.

Recruiters can use the chances of survival shown in table 12 to screen applicants. The chances vary widely even within quality categories: from 99 to 81 in the A category, 85 to 70 in the B category, 86 to 71 in the C category, and 72 to 60 in the D category for majority recruits. They can try to enlist men with the best chances when filling their quality category quotas. The recruiting command can even set limits within the categories to minimize quality subject to the supply of applicants. As a practical matter, however, about 60 percent of majority and minority recruits in CY 1973 had 12 years of schooling and no dependents, and another 30 percent had less than 12 years of schooling and no dependents (columns two and five in table 12). Most future accessions are likely to come from these sources.

TABLE 16

PREDICTED INPUT GIVEN DESIRED QUALITY MIX AND SURVIVORS

Quality category	Desired survivors	×	100 ÷ predicted survival rate	=	Predicted input
A	40,000		1.116		44,643
B	10,000		1.302		13,021
C	5,000		1.247		6,234
D	5,000		1.466		7,331
Total	60,000				71,229

RECOMMENDATIONS

Because the model developed in this study is current, comprehensive, and easy to apply, it merits use in establishing and modifying recruiting policy and as a replacement for the outdated OFE in screening applicants for enlistment.

CONTINUING WORK

Since this study is a longitudinal one, the CY 1973 non-prior service male cohort will be tracked through the second year of service using both pre-service and service experience variables. In addition, loss patterns will be compared for men who attended Class A School versus those who went to the fleet after recruit training; men assigned to different activities, such as surface, air, submarine, and shore units; and men in different paygrades and ratings. In each case, only men with equal lengths of service will be compared.

A CY 1974 non-prior service male cohort will be traced through the first year of service to check on the validity of the CY 1973 results. This will entail recalculating mental group using the Basic Test Battery scores for the men in CY 1974. Also, educational level will be studied further to determine possible differences in loss patterns between men who have high school GED equivalencies and men who have high school diplomas.

CY 1973 and 1974 cohorts of non-prior service women will be tracked in much the same fashion that the men were, that is, using both pre-service and service-connected data in relation to loss experience.

Since the Armed Services Vocational Aptitude Battery will eventually replace the Navy Basic Test Battery, plans also can be designed to develop chance tables using the ASVAB to determine mental groups. The object is to avoid the problem of conflicting results when two test batteries are used for selection to Class A School—witness the experience with the short and regular BTBs.

The goals of this continuing work are to (1) improve planning and screening methods and (2) explore reclassification possibilities at the end of the recruit training, Class A School, and the first year of service to reduce premature losses and their costs to the Navy.

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APPENDIX A

LOSS MODEL SPECIFICATION

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LOSS MODEL SPECIFICATION

The loss model hypothesized that the probability of separation during the first year of service for the *ith* group of male recruits, P_i, was a function of:

LT12ED	–	less than 12 years of education
*12ED	–	12 years of education
GT12ED	–	more than 12 years of education
MGI	–	mental group percentiles 93 and above
MGII	–	mental group percentiles 65 to 92
*MGIIIU	–	mental group percentiles 49 to 64
MGIIIL	–	mental group percentiles 31 to 48
MGIV	–	mental group percentiles 30 and below
AGE17	–	17 years old
*AGE18-19	–	ages 18 and 19
AGE20+	–	age 20 or older
*MAJ	–	racial majority
MIN	–	racial minority
PDEPS	–	primary dependents (wife, children)
*NDEPS	-	no primary dependents

Then

$$P_i = \alpha + \sum_{j=1}^{k} \beta_j X_{ij} + U_i$$

where α is an intercept that subsumes one dummy variable of each set (starred in the list above), U_i is the error term, the β_is represent the coefficients to be estimated, and the Xs are the dummy variables (not starred in the list above). Using these variables, and estimates of α and the βs found by multiple regression analysis in the model, we were able to predict the probability, P_i, of any individual (with a given set of characteristics) being lost during the first year of service.

For simplicity, we first assumed the linear functional form given above. But since the loss rate is a number lying between 0 and 1, we also estimated regressions using a logit transformation of the dependent variable (references 7 and 10):

$$\ln\left(\frac{P_i}{1-P_i}\right) = \alpha^1 + \sum_{j=1}^{k} \beta_j X_{ij} + z_i$$

where ln indicates the natural logarithm, the X_is are the independent variables from (2) above, and z_i is the error term.

Weighted ordinary least squares regressions for the linear and logit specifications were run. The weights for the groups were, respectively, $\sqrt{n/pq}$ and $\sqrt{npq}$, where n is the number of recruits in a group, p is the proportion of losses, and q is the proportion of survivors (references 11 and 12). Where there were no recruits for a particular combination of independent variables, that combination was

ignored. Where $P_i = 0$, the loss rate was taken as $i/2n_i$. Where $P_i = 1$, the rate was taken as $1 - 1/2n_i$ (reference 13).

Interaction effects among the dummy independent variables were explored with a computer program that identified optimal configurations of the variables (reference 14). The groups were split so as to maximize the between sum of squares for the categories of each independent variable while minimizing the error or within sum of squares. All possible splits are considered in the process. A total of 22 simple and complex significant interactions were identified and incorporated in the logit regression model. Although 3 of them proved to be significant at the 1 percent level, their practical contribution to explaining the variance of the dependent variable was negligible. Consequently, the final regression models contained no interaction terms.

APPENDIX B

DETAILED INPUT AND LOSS RATE DATA

TABLE B-1

CY 1973 INPUT AND FIRST YEAR LOSS DATA FOR MAJORITY RECRUITS*

Mental group	Age	More than 12 years of education: No dependents	More than 12 years of education: Dependents	12 years of education: No dependents	12 years of education: Dependents	Less than 12 years of education: No dependents	Less than 12 years of education: Dependents
I	18-19	(1.2) 3.8 182	(5.0) 0 6	(4.3) 4.4 1,279	(8.0) 11.3 62	(15.4) 11.5 26	(19.1) 0 1
	20+	(4.4) 4.3 552	(8.2) 6.8 103	(7.5) 6.2 273	(11.3) 6.0 83	(18.6) 16.7 6	(22.4) 0 4
	17	(2.7) 0 1	(6.5) 0 0	(5.8) 3.7 272	(9.5) 50.0 2	(16.9) 21.7 23	(20.6) 100 2
II	18-19	(6.1) 7.9 800	(9.9) 13.2 38	(9.2) 8.9 11,853	(13.0) 14.3 505	(20.3) 18.3 935	(24.1) 15.5 71
	20+	(9.4) 9.6 1,774	(13.1) 8.6 291	(12.4) 13.9 1,931	(16.2) 16.2 551	(23.5) 20.2 114	(27.3) 27.3 55
	17	(7.6) 0 4	(11.4) 0 0	(10.7) 12.6 2,936	(14.5) 12.0 50	(21.8) 20.1 1,601	(25.6) 21.4 42
IIIU	18-19	(8.8) 11.1 180	(12.6) 12.5 8	(11.9) 11.7 6,166	(15.6) 19.7 239	(23.0) 22.3 1,374	(26.7) 32.8 137
	20+	(12.0) 12.6 390	(15.8) 15.7 51	(15.1) 13.9 934	(18.9) 21.3 225	(26.2) 25.9 162	(30.0) 43.4 76
	17	(10.3) 0 0	(14.0) 0 0	(13.3) 13.3 1,811	(17.1) 21.4 28	(24.4) 23.5 2,779	(28.2) 28.4 67
IIIL	18-19	(14.0) 7.8 64	(17.8) 0 2	(17.1) 15.5 3,528	(20.9) 26.4 129	(28.2) 27.6 1,449	(31.9) 40.6 138
	20+	(17.2) 16.4 128	(21.0) 18.8 16	(20.3) 20.8 606	(24.1) 21.8 119	(31.4) 36.5 159	(35.2) 46.8 79
	17	(15.5) 0 1	(19.3) 0 0	(18.6) 18.8 1,049	(22.3) 34.8 23	(29.7) 29.7 3,065	(33.4) 34.0 53
IV	18-19	(18.8) 10.7 28	(22.6) 0 0	(21.9) 22.2 2,109	(25.7) 38.6 70	(33.0) 36.6 1,414	(36.8) 49.5 103
	20+	(22.0) 25.4 59	(25.8) 50.0 2	(25.1) 28.8 510	(28.9) 37.5 72	(36.2) 45.0 202	(40.0) 33.3 72
	17	(20.3) 0 0	(24.1) 0 0	(23.4) 27.2 514	(27.2) 21.4 14	(34.4) 33.2 2,668	(38.3) 34.6 52

*Key: (Predicted loss rate) Actual loss rate
Number of recruits

TABLE B-2

CY 1973 INPUT AND FIRST YEAR LOSS DATA FOR MINORITY RECRUITS*

Mental group	Age	More than 12 years of education		12 years of education		Less than 12 years of education	
		No dependents	Dependents	No dependents	Dependents	No dependents	Dependents
I	18-19	(0) 0 3	(1.6) 0 0	(0.9) 0 3	(4.6) 0 1	(12.0) 0 0	(15.7) 0 0
	20+	(1.0) 0 7	(4.8) 0 0	(4.1) 0 3	(7.9) 0 1	(15.2) 0 0	(19.0) 0 0
	17	(0) 0 0	(3.1) 0 0	(2.3) 0 0	(6.1) 0 0	(13.4) 0 0	(17.2) 0 0
II	18-19	(2.7) 11.8 17	(6.5) 0 2	(5.8) 7.0 227	(9.6) 9.1 11	(16.9) 4.2 24	(20.7) 66.7 3
	20+	(6.0) 6.1 82	(9.7) 8.3 24	(9.0) 15.2 68	(12.8) 4.0 25	(20.1) 11.1 9	(23.9) 0 0
	17	(4.2) 0 0	(8.0) 0 0	(7.3) 6.3 63	(11.1) 0 0	(18.4) 28.6 21	(22.2) 0 0
IIIU	18-19	(5.4) 6.7 30	(9.2) 0 1	(8.4) 8.0 402	(12.2) 31.3 16	(19.5) 27.2 92	(23.3) 33.3 3
	20+	(8.6) 12.7 71	(12.4) 10.5 19	(11.7) 14.4 118	(15.4) 22.6 31	(22.6) 30.0 20	(26.5) 14.3 7
	17	(6.9) 0 0	(10.6) 0 0	(9.9) 9.5 105	(13.7) 0 1	(21.0) 30.2 126	(24.8) 0 5
IIIL	18-19	(10.6) 18.8 32	(14.4) 0 0	(13.7) 18.7 697	(17.4) 19.2 26	(24.8) 37.5 251	(28.5) 43.8 16
	20+	(13.8) 6.5 107	(17.6) 3.4 29	(16.9) 20.4 196	(20.7) 22.6 31	(28.0) 35.9 64	(31.8) 64.3 14
	17	(12.1) 0 0	(15.8) 0 0	(15.1) 17.3 202	(18.9) 0 2	(26.2) 33.2 279	(30.0) 50.0 6
IV	18-19	(15.4) 22.7 22	(19.2) 0 2	(18.4) 15.5 1,267	(22.3) 13.9 36	(29.6) 33.2 584	(33.4) 28.0 25
	20+	(18.6) 14.4 104	(22.4) 21.4 14	(21.7) 20.6 403	(25.4) 28.6 70	(32.8) 30.1 143	(36.6) 40.0 30
	17	(16.9) 0 0	(20.7) 0 0	(20.0) 17.0 276	(23.8) 0 3	(31.1) 27.9 552	(34.9) 16.7 6

*Key: (Predicted loss rate) Actual loss rate
Number of recruits